Defense Technology International

AVIATION WEEK

An Editorial Supplement to Aviation Week & Space Technology

NOVEMBER/DECEMBER 2006

ON THE RECORD

Q&A

RISKY BUSINESS

The mission of the Defense Advanced Research Projects Agency (Darpa) is "to maintain the technological superiority of the U.S. military and prevent technological surprise by sponsoring revolutionary, high-payoff research that bridges the gap between fundamental discoveries and their military use." Its traditional strength has been its ability as a small, technology seed money agency with an expert technical staff and minimum bureaucratic red tape to respond to emerging military needs and technological opportunities and to independently pursue revolutionary solutions. In fact, to maintain its entrepreneurial atmosphere and flow of high-risk technical ideas, Darpa rotates program managers in and out of the agency, with most of them serving only 4-6 years. During an interview with Defense Technology International Managing Editor Glenn Goodman, Dr. Anthony J. ("Tony") Tether, Darpa's director since 2001, highlighted some of the agency's current research programs.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

DTI: Has Darpa's normal far-term research focus been diverted to some extent to meet the near-term needs of U.S. forces in Iraq and Afghanistan?

TETHER: No, we've actually been able to tap previous as well as ongoing research efforts to help meet those needs. One example is a sniper-location system. Its key technological hurdle was getting it to work on a moving vehicle because of the air flow noise picked up by its acoustic microphones. We overcame that hurdle in the late 1990s, but there was no urgent military requirement for the system, so it went on the shelf. After the war in Iraq began, the Army contacted us and said its vehicle convoys were coming back all shot up and the crews didn't even know they'd been under fire because of road noise. So we reconstituted the earlier program as the Boomerang shooter detection and location system, which alerts soldiers in a convoy if they are being shot at and where the shots are coming from. It has performed well in Iraq and costs less than $10,000 per system.

In the case of other advanced technology projects, we've spun off near-term applications for current military operations that aren't as advanced as the ultimate results of those projects will be. An example is automatic language translation technology, which we've worked on for many years. We deployed a one-way, hand-held, phrase translator in Iraq and Afghanistan a few years ago that has proven useful in allowing our soldiers to talk to locals. Our real goal, of course, is to develop a two-way translation device that can handle any conversation. In the interim, we're trying out a two-way device in Iraq that works in more limited situations, such as at a checkpoint, and can recognize and translate typical phrases and instructions.

DTI: One of Darpa's strategic thrusts is improving the ability of U.S. forces to operate in urban areas. What are some of your technology efforts in that domain?

TETHER: One of the major differences in fighting in cities compared with non-urban areas is that our soldiers don't have good situational awareness, even of what's happening just a block away. So we've been developing advanced technologies to overcome that problem. They include ducted-fan unmanned aerial vehicles [UAVs] with vertical takeoff-and-landing capability [see July-Aug. *DTI*]. Ducted-fan UAVs can fly slowly, which is what you need in an urban environment, and can provide surveillance video of areas a block or two away. We could use little unmanned helicopters, but ducted-fan UAVs offer greater efficiency than rotary-wing UAVs. They can hover alongside a building and stare inside and also can perch on the corner or top of a building. We've also developed a micro-UAV, a little airplane called Wasp that has only a 14-inch wingspan and weighs a half-pound. It can be launched with the flick of the wrist and fly around the corner, as quiet as a bird. It's on the way to Iraq now for experimental use by the Marines. Our soldiers can launch these two types of UAVs quickly, so they will help buy back the situational awareness we've lost in urban areas.

Another military need in urban operations is for precision weapons with very small explosives to minimize collateral damage. We're making great progress in that area. One of our programs is called Close Combat Lethal Recon. It's a tube-launched cruise munition that can be used by a dismounted infantryman in an urban area to attack a target, perhaps spotted by a UAV, which is beyond his line of sight. It's like a small mortar round with a grenade-size explosive in it. A fiber-optic line unreels from its back end and provides the data link that allows the soldier to see the video from the munition's camera and to fly it into the target.

The Command Post of the Future that we developed and transitioned to the Army is proving very effective in operations in Iraq. It's a distributed command-and-control system that creates a virtual command post. A commander and subordinate unit leaders typically are in different locations and have to get together physically to collaborate and talk over a new plan. CPOF ["see-poff"] lets everyone stay where they are and watch a common geographic computer display simultaneously that shows unit locations. It features a "John Madden" white-boarding capability so the commander or subordinates can draw arrows or diagrams on the display to illustrate their ideas [like using an easel in a conference room] and everyone can see the diagramming and converse with each other using Voice-over-IP like a conference call to brainstorm a new plan. I was in Iraq a month ago for a week, and CPOF is everywhere and Army commanders love using it.

DTI: Cognitive Computing is another Darpa research thrust. What's that all about?

TETHER: We use, as an analogy, the character "Radar O'Reilly" on the old M.A.S.H. television program. He always seemed to know what the colonel needed even before the colonel knew he needed it. He was like a cognitive computer. He learned what the colonel needed and could anticipate what he'd be asking for. Imagine if we could have a computer that could do that for you. Cognitive computers would adapt to their user instead of the other way around and anticipate the user's needs, acting as a support staff and freeing humans to focus on what they do best – thinking analytically and creatively.

One of the benefits would be in streamlining support personnel functions. If we are going to have an agile and mobile force, we can't afford to have a 10:1 or 20:1 tail-to-tooth ratio [support personnel to warfighters with weapons] and have to transport that tail with the fighting forces. What we're trying to do with the cognitive computing program is to reduce that tail and let the computer be more of a helper instead of a tool that requires 10 people to maintain. If you look at tactical operations centers, there are often hundreds of people in them, and sometimes a fourth of those folks are performing nothing but computer maintenance or infrastructure support functions. There's no reason why it has to be that way. If you had a computer that maintained itself and learned about you over time – learned your preferences and could anticipate your needs – then all that manpower staff wouldn't have to be there. Cognitive computers also could generate options for a commander like a staff does and predict the result of various courses of action.

DTI: Darpa has held Grand Challenge prize competitions in the area of unmanned ground vehicles. Have they helped accelerate the development of those vehicles?

TETHER: Absolutely. The competitions, which have drawn on a larger base of engineers than our typical research programs, are helping to create a major new military capability – autonomous ground vehicles. There were people who never would have believed that robotic vehicles could travel these kind of distances and reach their destinations – 132 miles through difficult desert terrain in less than 10 hours. Grand

Challenge proved that it could be done. The next step is Urban Challenge, which we will hold in Nov. 2007. The autonomous vehicles will have to negotiate a 60-mile course through an urban area in less than six hours to prove their utility in military supply missions. They will have to obey traffic laws while merging into moving traffic and navigate traffic circles and busy intersections.

The reason we picked autonomous ground vehicles for Grand Challenge was not just because of the military need, but because we are worried about the declining numbers of kids in high school and college going into the fields of engineering and science & technology. Grand Challenge was our attempt to create a competition that might excite young people to participate. And, quite frankly, it was a tremendous success, beyond our expectations. Our 2005 Grand Challenge drew 95 teams from 36 states, including 35 from universities and three from high schools, and 17 university teams made it to the final qualifying event.

TETHER'S FUTURE ICONS

- Low-cost titanium ($2.50/lb. military-grade alloy)
- Bio-warfare (accelerate development and production of therapeutics and vaccines from 12+ years to 12 weeks)
- Tango Bravo (cheaper, smaller, Navy Virginia class-capable attack submarine)
- Quantum information science
- Networks (self-forming, robust, self-defending at strategic and tactical levels)
- Information operations (non-kinetic capabilities)
- Global war on terrorism (determine, track and neutralize the leaders)
- Air vehicles (fast-access, long-loiter)
- High-energy liquid laser area defense system
- Space dominance
- High-productivity computing system
- Real-time, accurate language translation
- Grand Challenge

DTI: Darpa has had two long-term airship programs that are separate from the Missile Defense Agency's near-term High-Altitude Airship. How do they differ?

TETHER: One of our two programs, called Walrus, was exploring heavier-than-air vehicle designs about 300 meters long that could ferry military personnel and equipment around the world, with little in the way of support equipment or facilities. The airship would generate lift through a combination of aerodynamics, thrust vectoring and gas-buoyancy generation and management. Unfortunately, Congressional appropriators zeroed the program's funding for the second year in a row in our Fiscal Year 2006 budget. We couldn't convince them that it was a good idea.

Our "Integrated Sensor is Structure" or ISIS program, implemented by the Air Force Research Laboratory at Rome, N.Y., envisions an unmanned airship 150-300 meters long with a lightweight radar antenna of unprecedented size that would track ground and airborne targets while hovering above the jet stream at altitudes of 65,000-70,000 ft. for up to a year at a time. The idea is to make the sensor payload and the airship structure one and the same by using the hull as the support structure for the antenna. The antenna would be very thin and would be bonded to the hull to save thousands of pounds of weight. The payload aboard the High-Altitude Airship represents about 1.7 percent of the platform's overall weight, while the payload aboard ISIS would account for 30%-40% of it. ISIS is a difficult technological challenge.

DTI: Would ISIS be a cheaper alternative to a Space-Based Radar?

TETHER: If we can do it, we'll certainly have a larger aperture [antenna] than any other radar. With a Space-Based Radar constellation, any spot on the globe would be under surveillance. With ISIS, you'd have to fly it there, but once it arrived, it would provide a far greater capability than a Space-Based Radar. In addition, it should be only a fraction of the cost of a Space-Based Radar constellation.

DTI: Could you tell our readers about Darpa's Falcon program?

TETHER: Our Falcon program is designed to vastly improve the U.S. capability to reach orbit affordably. The problem we have is that the cost of going to space is so high that it prevents us from being able to experiment and test prototypes or satellite subsystems in space to reduce risk earlier in their development [prior to costly, full-blown system launches]. So we're pursuing ways to launch small payloads in the 1,000-lb. class into low earth orbit for less than $5 million.

We're funding the development of two types of small launch vehicles – one is a booster rocket from SpaceX that doesn't require a very sophisticated launch pad and the other is an air-launched system. Last July, a full-scale mockup of a 72,000-lb. rocket from the company AirLaunch was successfully dropped out the back of a C-17 transport flying at 32,000 feet. The rocket's engine would ignite after separating from the aircraft and carry a small satellite into space. The neat thing about having a moveable launch pad like that is it could be used on short notice and the rocket could be dropped off virtually anywhere to reach a wide variety of orbits.

The small launch vehicle portion of the Falcon program also is intended to support a second part of the program, which involves flight testing hypersonic test vehicles in near space to assess designs, components and materials for a future reusable hypersonic cruise vehicle that could revolutionize space access and near-space transportation. We're developing it in small steps, beginning with a glider that can withstand heat in the atmosphere at Mach 10 and make big turns, thousands of miles across. The vehicle won't be married with an engine until well after 2010.

DTI: Another Darpa thrust is detecting underground facilities. Are you making progress?

TETHER: Most of the work is highly classified, but we've made good progress. We are developing ground and airborne sensor systems for imaging the layouts of large, deeply buried underground structures. Let me say that we don't necessarily find them – someone else tells us where they believe an underground facility is located. The technologies we are developing would allow us to get a good picture of what is under the ground. Why is that important? Well, if you know where the power-generation equipment is physically located, then you can put a much smaller bomb into that area and knock out the whole facility, short of having to use an enormous bomb.

DTI: What is the status of Boeing's Darpa-funded A-160 Hummingbird UAV?

TETHER: It still looks like it has a future. The A-160 is a 35-ft.-long, lightweight unmanned helicopter with a variable-speed rotor. It potentially offers the range and endurance of a Predator UAV – our goal is 32 hours endurance at 15,000 feet. The A-160 also can hover, which is really useful if you want to be able to detect objects that are moving on the ground very slowly, such as people walking. One of the major errors with moving-target-indicator radar is the motion of the airborne platform that is carrying the radar, because that velocity introduces "noise" and the minimal discernible velocity is large. If you can keep the platform stationary in a hover, you minimize the amount of noise and make the minimum discernible velocity as small as it possibly can be, to the point that you can even track people walking.

DTI: Were you disappointed when the Darpa-managed J-UCAS [Joint Unmanned Combat Air System] was terminated soon after it transitioned to the Air Force a year ago?

TETHER: Darpa's programs at times have taken different paths to fielding by one of the services or U.S. Special Operations Command. For example, we started the Global Hawk UAV back in the 1970s and the Predator UAV in the early 1980s, and they subsequently went through several incarnations. Unmanned combat air vehicles that can do more than just carry sensors are coming. J-UCAS paved the way, and Predator is being used with weapons and sensors today. The J-UCAS technologies didn't make it this time, but they will come around again. The X-45A laid the groundwork for future unmanned combat aircraft with its 64 mishap-free demonstration flights. Darpa's job is to show that something is technically feasible. It doesn't mean that people are automatically going to use it, because there are funding and other issues involved. But they can't say that it can't be done.

DTI: What are some other Darpa-funded advanced technologies that you are excited about?

TETHER: There are so many, ranging from low-cost titanium to prosthetics that will be controlled by your mind to lasers that will be tactically useful because of their size. I have a list of "future icons," technologies that we think future Darpa directors will point to as significant achievements of this era [see box]. Let me elaborate on two of them.

Extracting titanium from titanium oxide is very difficult. Someone in England had the idea that, instead of taking out the titanium as we do with aluminum oxide, why not just take the oxygen out and leave the titanium behind? That simple idea has turned out to be the nucleus of a real breakthrough and could reduce the price of titanium from $16 to $30 per pound to $2.50 per pound. If it gets down to $4 per pound, the Navy would start using it for all the piping on its ships. Why? Because it is corrosion-resistant. There would be tremendous savings alone from being able to reduce the number of sailors who do nothing but fix pipes.

A bio-technology that Darpa is funding has the goal of creating vaccines in days instead of years and months. Currently, if the Avian flu hit, even if we knew the vaccine, we could only make it in extremely limited quantities. We have programs to overcome that by going to a whole different process – a fermentation process – so perhaps at a beer manufacturer's fermentation plant they could make beer Monday through Thursday and on Friday they could make vaccine.

DTI: Any final words?

TETHER: We turn over program managers here at Darpa at a rate of 25% per year. We have to replace 25-30 top-notch thinkers every year because they are term employees. I would like you to spread the word that Darpa is a great place to work for people with innovative ideas and concepts that are ready to be brought from the theoretical to the practical realm and could potentially benefit U.S. military forces. If anyone has novel ideas that they can't find support for anywhere else, come see us. Being a Darpa program manager is the best job in the world while you are here, and you couldn't find a better investment for your future career. Everyone wants to hire former Darpa PMs. ■

Posted from Defense Technology International, November/December 2006, copyright by The McGraw-Hill Companies, Inc. with all rights reserved.
The reprint implies no endorsement, either tacit or expressed, of any company, product, service, or investment opportunity.
#1-19615153 Managed by Reprint Management Services, 717.399.1900. To request a quote online, visit www.reprintbuyer.com.